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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

INVENTOR(S)

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☐ Additional inventors are being named on the ____ separately numbered sheets attached hereto 0

TITLE OF THE INVENTION (280 characters max)

STEREOSCOPIC DISPLAY SYSTEMS

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ENCLOSED APPLICATION PARTS *(check all that apply)*

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☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

☒ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

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☒ No

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Respectfully submitted,

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Our file:	GB/fd/13853.6
Applicant:	Écrans Polaires Inc.
Application No.:	Not attributed
Title:	STEREOSCOPIC DISPLAY SYSTEMS
Encl.:	Application (29 pages), drawings (18 sheets)

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TITLE OF THE INVENTION

Stereoscopic display systems

FIELD OF THE INVENTION

[0001] The present invention relates to stereoscopic display systems. More specifically, the present invention is concerned with high quality flat panel stereoscopic display systems.

BACKGROUND OF THE INVENTION

[0002] Stereoscopic technology is used to create realistic games or scenery providing depth to objects, by presenting a unique view to each eye almost the same way one would view objects in real life (See Figure 1). In polarization technology, linear polarized and circularly polarized lights as well as a combination thereof, referred to as elliptically polarized light, shown in Figure 2, are used.

[0003] A conventional stereoscopic display system generates two images polarized at 90° from each other and uses passive polarized stereoscopic glasses comprising two filters at 90° from each other. The diagram of Figure 3 illustrates such a system, where **L.I.** is a left image intended to be seem by the left eye only, **R.I.** is a right image intended to be seem by the left eye only, **L.F.** is a polarized left filter, which lets only the left image go through, and **R.F.** is a polarized right filter, which lets only the right image go through. This polarization system may be represented by a graphic as shown in Figure 4.

[0004] In LCD (liquid crystal display) technology, three types of

active matrix Thin Film Transistor (TFT) LCD are used: Twist Nematic (TN), In-Plane Switching (IPS) and Multi-domain Vertical Alignment (MVA). Figure 5 shows an example of AM-LCD TN (Active Matrix LCD). A LCD display consists essentially of two sheets of glass separated by a sealed-in liquid crystal material, which is normally transparent. A voltage applied between front and back electrode coatings disrupts an orderly arrangement of the liquid crystal molecules, darkening the liquid enough to form visible characters (see Figure 6, Figure 7).

[0005] In a United-States patent No. 5,629,798 issued to the present applicant, the ability to display two different images on the same display is applied to create a deep 3D perception by showing two images from a different point of view representing each eye, as in stereoscopy, with a unique advantage of displaying the two images without multiplexing them in time nor in space as is usually the case in most others stereoscopic technologies. The method consists in adjusting, for each picture element individually, the intensity of light as a function of the intensity value of two corresponding pixels in the left and right images, and polarizing, for each picture element individually, at an angle as a function of the value of the two corresponding pixels of the left and right images. The resulting display is similar to any conventional LCD monitor but it comprises two LCD panels. As illustrated in Figure 8, the basic display assembly consists of a series of layers, comprising, from back to front, a back light, a polarized filter, a first LCD panel, a polarized filter and a second LCD panel. The first LCD panel controls the pixel intensity for both eyes while the second LCD panel controls the distribution to one eye or the other. To generate a stereoscopic image, the left and right images are converted into a modulo (driving the first LCD) and an angular (driving the second LCD) images using the following relations:

$$\text{Modulo} = \sqrt{(\text{left}^2 + \text{right}^2)} \qquad (1)$$

$$\text{Angular} = \arctan\left(\frac{\text{left}}{\text{right}}\right) \qquad (2)$$

[0006] The light coming out of every pixel may be written in polar complex number notation as follow:

$$\left(\sqrt{(\text{left}^2 + \text{right}^2)}, \ \arctan\left(\frac{\text{left}}{\text{right}}\right) \right) \qquad (3)$$

[0007] The orthogonal polarized filters of the passive glasses recreate he left and the right image for the left and the right eyes, since these polarized filters act as cosine and sine trigonometric functions as follows:

$$\text{Cos} \left(\sqrt{(\text{left}^2 + \text{right}^2)}, \ \arctan\left(\frac{\text{left}}{\text{right}}\right)\right) = \text{left} \qquad (4)$$

$$\text{Sin} \left(\sqrt{(\text{left}^2 + \text{right}^2)}, \ \arctan\left(\frac{\text{left}}{\text{right}}\right)\right) = \text{right} \qquad (5)$$

[0008] There is room for further improvements in the field of high quality flat panel stereoscopic displays.

SUMMARY OF THE INVENTION

[0009] In accordance with the present invention, there is provided a high quality flat panel stereoscopic display.

[0010] Other objects, advantages and features of the present invention will become more apparent upon reading of the following non-restrictive description of embodiments thereof, given by way of example only with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In the appended drawings:

[0012] Figure 1, labeled "Prior Art", is a schematic diagram of a stereoscopic method as known in the art;

[0013] Figure 2, labeled "Prior Art", is a diagram of linear, circular and elliptical lights as used in polarization technology;

[0014] Figure 3, labeled "Prior Art", is a diagram of a conventional stereoscopic display system;

[0015] Figure 4, labeled "Prior Art", is a graphic representation of the polarization system of Figure 3;

[0016] Figure 5, labeled "Prior Art", is an example of an AM-LCD TN display;

[0017] Figure 6, labeled "Prior Art", is a cross section of the LCD display of Figure 5;

[0018] Figure 7, labeled "Prior Art", shows the alignment of the liquid crystal molecules of the system of Figure 6 under an electric charge;

[0019] Figure 8, labeled "Prior Art", illustrates a LCD display system comprising two LCD panels;

[0020] Figure 9 is a graphic representation of a non-orthogonal polarized stereoscopic display according to an embodiment of a first aspect of the present invention;

[0021] Figure 10 is a diagram of the non-orthogonal polarized stereoscopic display of Figure 9;

[0022] Figure 11 is a diagram of conversion from an orthogonal system into an oblique system;

[0023] Figure 12 is a graphic representation of the non-orthogonal polarized stereoscopic display of Figure 9 in polar coordinates;

[0024] Figure 13 is a diagram of the non-orthogonal polarized stereoscopic display according to an embodiment of the present invention in the polar coordinates of Figure 12;

[0025] Figure 14 is a comparative illustration of a conventional LCD and a LCD with enhanced contrast and color resolution according to an

embodiment of an aspect of the present invention;

[0026] Figure 15 is an example of a LCD display using micro-lens arrays to collimate light within every color sub-pixel, according to an embodiment of an aspect of the present invention;

[0027] Figure 16 is an example of a LCD display using a front diffuser and incident back light, according to an embodiment of an aspect of the present invention;

[0028] Figure 17 is an example of a LCD display using micro-lens arrays to replicate the image of a first LCD on a second LCD, according to an embodiment of an aspect of the present invention; and

[0029] Figure 18 is an example of an integrated LCD according to a further embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0030] According to an aspect of the present invention, there is provided a polarized stereoscopic system wherein, contrary to that of Figures 3 and 4 discussed earlier, 1) the two polarized filters are not necessary located at 90°, 2) the angle of the polarized image is not the same as the corresponding polarized filter i.e. the left filter is not at the left image angle and the right image is not at the same angle than the right filter, and 3) the system of angles is selected is such a way to cancel stereoscopic cross-talk.

[0031] As shown in Figure 9, this polarized stereoscopic system is a

non-orthogonal polarized stereoscopic display system that generates two images polarized at an angle ω from each other (where $\omega = \alpha + \beta$). It makes use of passive polarized stereoscopic wearing glasses (see Figure 10) with a left linear polarized filter **L.F.** at an angle "A", which is at 90° from a linear polarization angle of a right image **R.I.**, and a right linear polarized filter **R.F.** is at an angle "B", which is at 90° from a linear polarization angle of a left image **L.I.**.

[0032] In such a system, the intensity of the left image **L.I.** after passing thought the left filter **L.F.** is attenuated by a factor of cosine of the angle between the left filter **L.F.** and the left image **L.I.**, i.e. $\cos(A - \alpha)$. Moreover, the intensity of the left image **L.I.** after passing thought the right filter **R.F.** is null since the angle (α + B) equals 90° by design and Cos (90°) equals zero. Likewise, the intensity of the right image **R.I.** after passing thought the right filter **R.F.** is attenuated by a factor of cosine of the angle between the right filter **R.F.** and the right image **R.I.**, i.e. cos (B - β), and the intensity of the right image **R.I.** after passing thought the left filter **L.F.** is null since the angle (β + A) equals 90° by design and cos (90°) equals zero.

[0033] Figure 10 shows an example of this non-orthogonal polarized stereoscopic display system of the present invention. As in the present applicant's previous patented polar stereoscopic display system discussed hereinabove, a pixel is subdivided in 3 sub-pixel controlling the red, green and blue intensities of the pixel, and each corresponding sub-pixel of the left and the right respectively is converted into **Modulo** and **Angular** values used to drive a first and a second LCD of the polar stereoscopic display, following relations (1) and (2) given hereinabove, where **left** is to a value of the sub-pixel of the left image corresponding to a same sub-pixel on the right image, and **right** is a value of a sub-pixel of the right image corresponding to a same sub-

pixel on the left image.

[0034] To use the polar system with the non-orthogonal system, the left and right values are converted from a 90° system to an oblique system (which has an angle of ω) as shown in Figure 11, where **L** refers to the value of the sub-pixel of the left image corresponding to the same sub-pixel on the right image, **R** is the value of the sub-pixel of the right image corresponding to the same sub-pixel on the left image, **x** is the transformed **L** value, **y** is the transformed **R** value, $\omega = \alpha + \beta$ is a polarization angle between the two images, and $\theta = A - \alpha$ is a polarization angle between the left filter and the left image.

[0035] The x and y values may be calculated using the following relations:

$$x = L\cos(\theta) + R\cos(\omega + \theta) \quad (6)$$

$$y = L\sin(\theta) + R\sin(\omega + \theta) \quad (7)$$

and relations (1) and (2) become:

$$\text{Modulo}' = \sqrt{(x^2 + y^2)} \quad (8)$$

$$\text{Angular}' = \arctan\left(\frac{y}{x}\right) \quad (9)$$

[0036] Using relations (6) and (7), relations (8) and (9) yield:

$$\text{Modulo}' = \sqrt{\left(L^2\cos^2\theta + 2\ L\ R\cos\ (\omega + \theta) + R^2\cos^2(\omega + \theta)\right)} \quad (10)$$

$$\text{Angulo}' = \arctan\left(\frac{L\cos\theta + R\cos(\omega + \theta)}{L\sin\theta + R\sin(\omega + \theta)}\right) \quad (11)$$

[0037] Applying the **Modulo'** and **Angular'** transformation to a polar stereoscopic display gives a polarized angle with a range of ω (from α to β) as show in the diagram of Figure 12. **L.O.** is a left orientation of a sub-pixel angle value, when the right sub-pixel value is zero or negligible compared to the corresponding left sub-pixel value. It is a minimum generated angular value. **R.O.** is a right orientation of a sub-pixel angle value, when the left sub-pixel value is zero or negligible compared to the corresponding right sub-pixel value. It is a generated maximum angular value.

[0038] The recovery of **L** and **R** from **Modulo'** and **Angular'** with filter at **A** and **B** angles may be demonstrated mathematically.

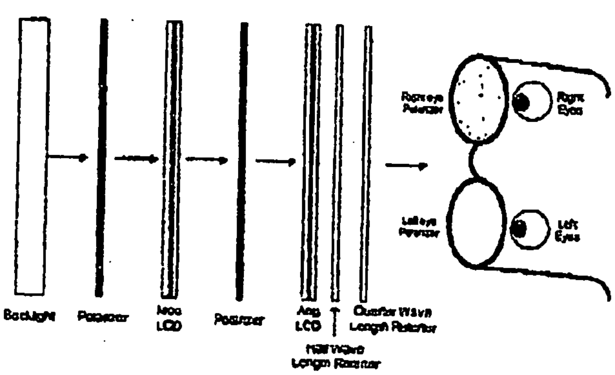
[0039] The diagram of Figure 13 shows the resulting non-orthogonal polarized polar stereoscopic display system. All principles of the non-orthogonal linear polarization system apply to circular polarization stereoscopic system. A conventional circular polarized stereoscopic display system uses left-handed and right-handed circular polarized filters to separate the left and the right images. The transformation from a linear polarized system to a circular polarized system and vice versa is performed by means of quarter length retarder films, wherein a fast axis of a retarder film placed at mid angle between the left and the right linear polarized angle transforms the linear polarized light into circular polarization light. In a non-orthogonal circular polarization stereoscopic display system, the linear polarization is thus transformed into an elliptical polarization light by using appropriate elliptical polarized filters instead of the circular polarized filter.

[0040] Interestingly, this aspect of the present invention accommodates a low angular range of available commercial LCD panels. Few of these commercial AM-LCD panels turn the light with a range of at least 90°.

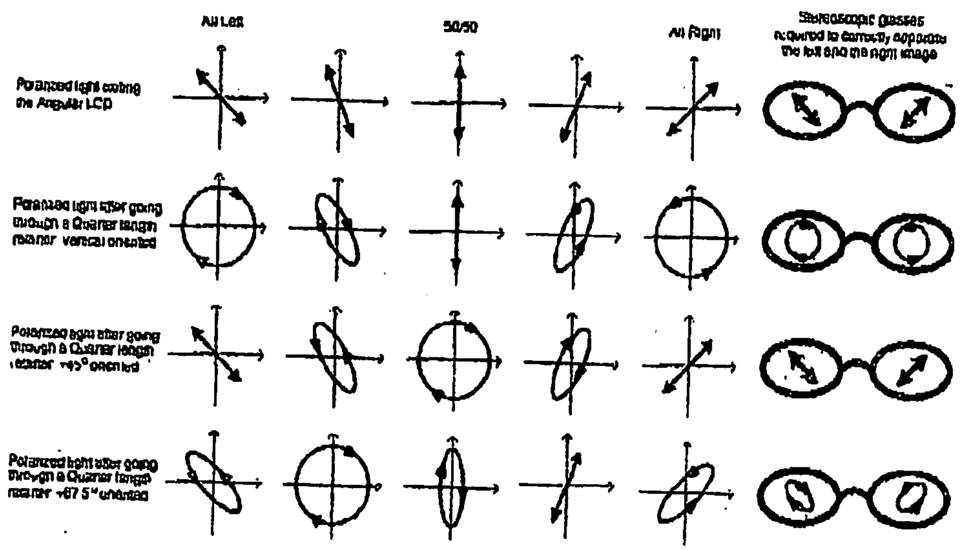
Ranges vary depending on technologies, such as TN, IPS or MVA, on manufacturers, and on LCD channel amplifier bias, between as low as 65° up to 85°. A major problem is that such ranges vary between each primary color. For example, one tested panel may have the red varying from 45° to -25° while the blue varies from 45° to -40°. The non-orthogonal polarized stereoscopic system of the present invention may be adapted for each color, based on the same common polarized glasses.

[0041] People in the art will further appreciate that this aspect of the present invention allows a zero cross-talk in a polar stereoscopic display system, as well as a faster switch in a CRT-LC panel stereoscopic display system, and a capacity to overdrive LCD at the extremes ends of angle swing for faster response. Moreover, it provides a viable system able to display two independent images polarized at an angle other than 90°.

[0042] In a further aspect of the present invention, there is provided an elliptical polarized stereoscopic display system, by adding a haft-length retarder and a quarter-length retarder sheet in the front of the display as illustrated in the diagram below:



[0043] The orientation of th optical axe of the retarder sheet affects the paradigm of the polarization stereoscopic. The diagram below shows the affect of a quarter length retarder at different orientations:



[0044] Moreover, the half-length retarder sheet may modify the orientation range of the linear polarization portion of the light resulting in even more permutation of linear and circular polarization system. This system may be combined with the non-orthogonal stereoscopic display system described hereinabove for even more permutations.

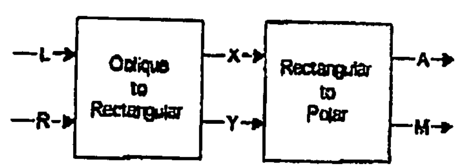
[0045] Some of these permutations allow the selection of stereoscopic glasses where the left and the right elliptical polarized filters have the same amount of light going therethrough when the glasses are placed in front of each other Therefore, a person wearing the glasses of the present invention may look comfortably at another person wearing the same glasses. Also some permutations of filter allows a comfortable use by people wearing

them to look at another LCD monitor.

[0046] People in the art will appreciate that this aspect of the present invention solves the discomfort encountered in others stereoscopic polarized glasses, when looking at regular LCD monitor (one eye see the image on the monitor but the other eye see black image) and when looking at another person wearing the same glasses (one eye see only one eye of the other person and the other eye see the opposite) which is rely confusing for the brain.

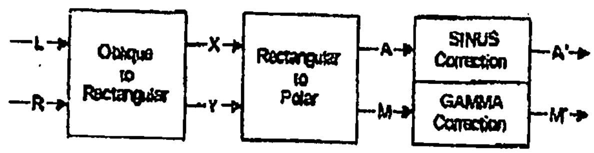
[0047] There is further provided a lock-up table for rectangular to polar conversion system to convert live video, described hereinbelow in details, which allows resolving high processing power required to transform left and right images in Modulo and Angular images in real time, and also allows reducing cross-talk by individual combined values (left and right color values).

[0048] A basic transformation of a non-orthogonal polarized stereoscopic display for every sub-pixel is show in the following diagram:

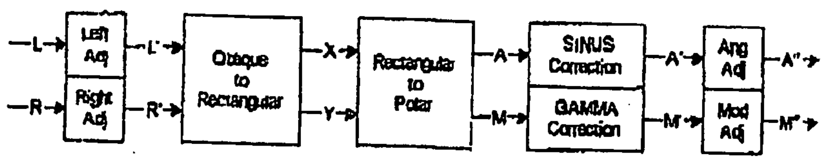


[0049] The pixel light intensity of a regular LCD monitor has a linear, with or without gamma correction, response to the voltage or value of the video signal input. For the modulo signal of a polar system, a Gamma correction is introduced t to the Modulo feed in order to obtain a linear LCD pix l, and a Sinus transformation is used to compensate the LCD light intensity linear

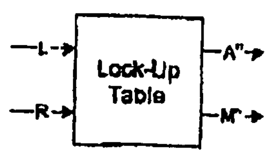
response so that the Angular signal generates a linear angular response, as follows:



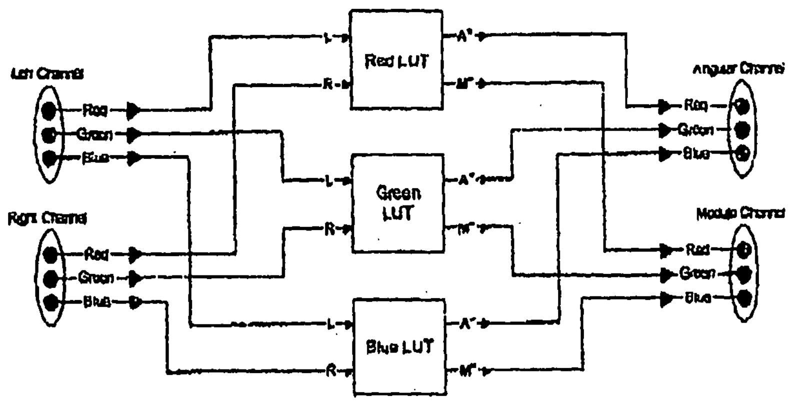
[0050] Adjustment may be further added to compensate for non-perfect response of LCD panel due to polarized filter and electronic, as follows:



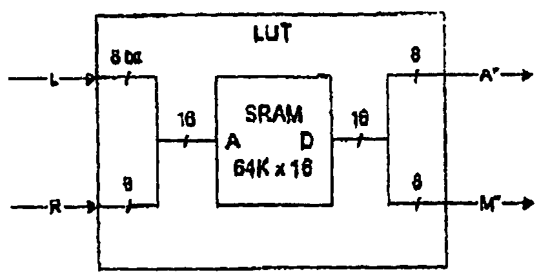
[0051] All these processing may be pre-calculated and stored in a memory that is used as a Lock-up table, as follows:



[0052] Since each pixel color may have different parameter, 3 LUT (Lock-Up Tables) are used, one for each color:



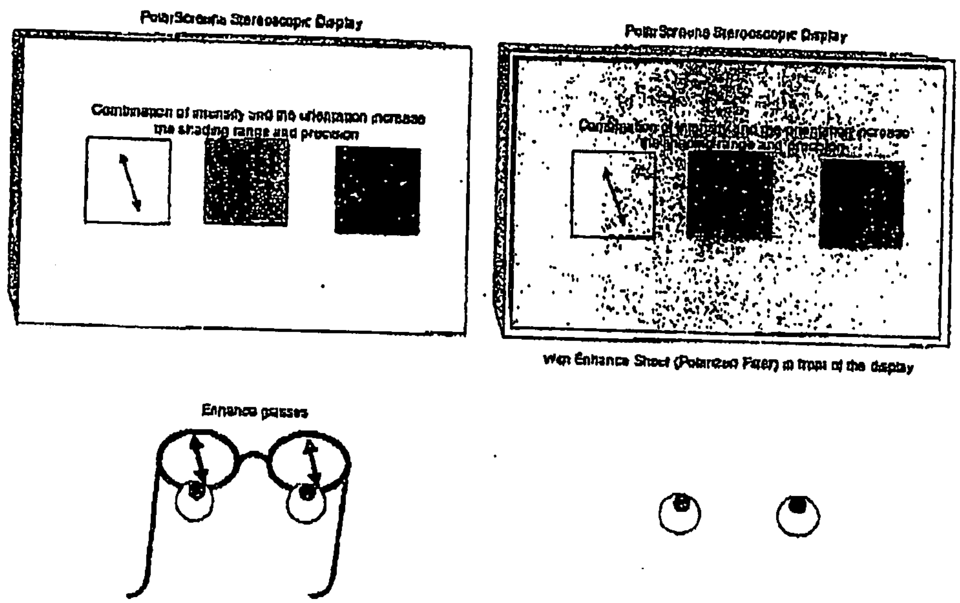
[0053] The LUT may be implemented in SRAM (static random access memory).



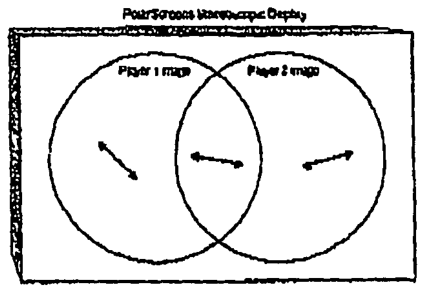
[0054] People in the art will appreciate that the LUT (Lock-Up Table) is a unique cheap way to achieve a sub-pixel frequency of a 1280x1024 at 85 Hz refresh rate, which requires a transformation processing clocked at 480 MHz. Moreover, the LUT makes it easier to add adjustment.

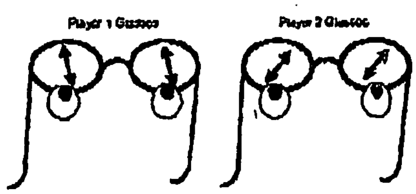
[0055] The present invention further provides a method and system for enhanced contrast and color resolution. The quality of a polar display in normal mode (2D) of the present invention may surpass currently available LCD displays by using the front LCD as a second light valve and controlling

both LCD's in conjuncture in order to increase a number of available intensity levels. It is also possible to obtain blacker black pixel intensity by blocking more light using both LCD's. Simply wearing a different type of polarized glassed (not 3D i.e. both eyes have the same angle) or putting a removable filter sheet on top of the display activates the second LCD as a light valve, instead of as a light twister in stereoscopic mode, which results in more than twice the contrast ratio, 10 bit per color resolution, as illustrated below:

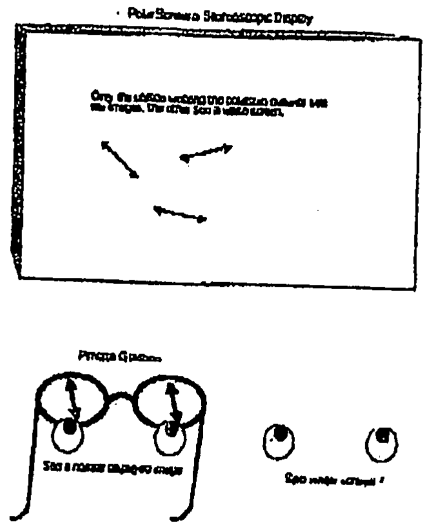


[0056] Such a method and system may be used to provide security displays wherein only the person wearing the polarized glasses (same as for enhanced contrast) is able to see the screen while other people only see a white screen, by showing the image on the second LCD while displaying a complete white image on the first LCD:





[0057] In the case of two players for example, with two displays and same screens, each player sees different images on the same display. The first player wears glasses with both eyes at the first polarized orientation and the second player wear glasses at the second polarized orientation. The two orientations may be orthogonal or non-orthogonal as with the non-orthogonal stereoscopic display system discussed earlier hereinabove:

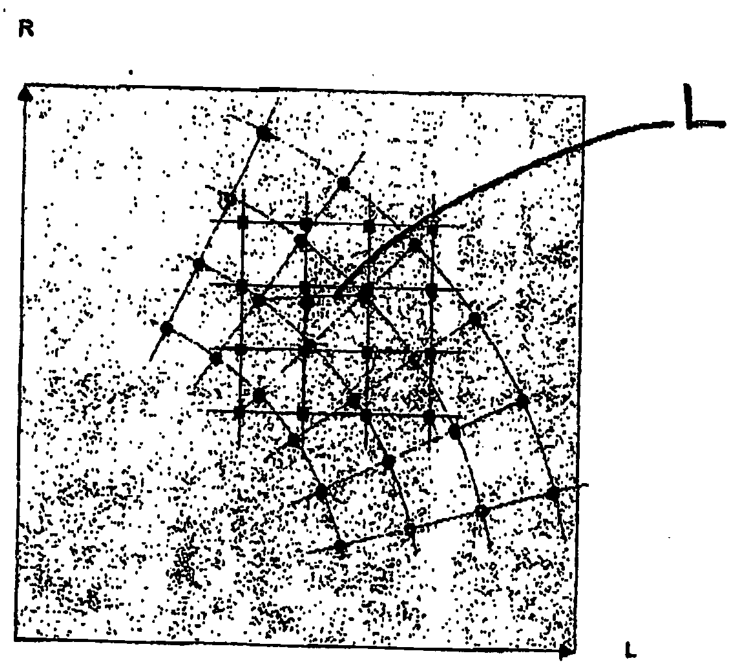


[0058] Therefore, the display may switch, at the push of a button, between a normal 2D screen, a stereoscopic screen (by wearing passing 3D glasses), an enhanced 2D screen (by adding a film on the display surface), a security display screen (where only the person wearing special glasses see the image), and a two players- two displays- same screens- full screens display screen.

[0059] Cross talk may also be reduced by using 2D matrix average of alternative display field.

[0060] The digitalization (convert the signal to discrete levels, for example 256 levels) of the Modulo and Angular signal leads to quantization errors that in turn cause cross-talk. Even if the Cartesian to polar conversion is errorless, an error caused by rounding of the Modulo and Angular number may create a small difference between the original left and right value and the

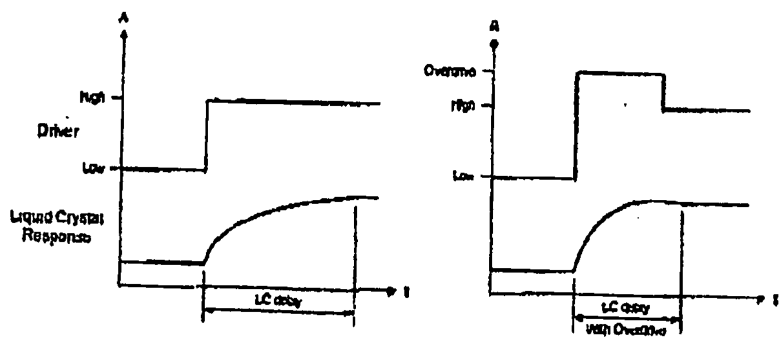
display intensities. The diagram below shows a portion of a left-right discrete matrix (in black), and a Modulo-Angular (in red) discrete matrix. The system makes use of the closest Modulo-Angula discrete values to represent the left-right values but, as shown on the diagram, for some values combinations, the error may be quite large resulting in quantization errors and cross-talk. To minimize the error, it is contemplated to toggle at every video frame (or at a different rate but fast enough to prevent any flicker perceived by the user) between two Modulo-Angular discrete values so that an obtained average is closer to the left-right values. An example of such a method is shown by the line referred to as L in the diagram below:



[0061] Cross-talk may be further reduced for fast moving images

using LCD overdrive technique and using pre-angular adjustment, as will now be described.

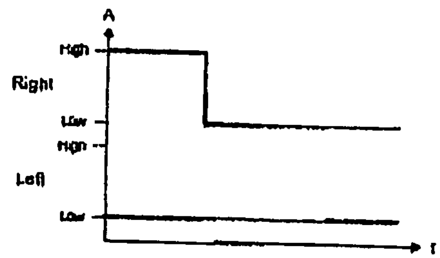
[0062] Driving a signal to a LCD at a level further during a short period of time (like one video frame for example) accelerates a change of orientation of the LC crystal to obtain the final value faster. As show in following diagram, the delay before the LC pixel has reach is set value is shorter with overdrive:



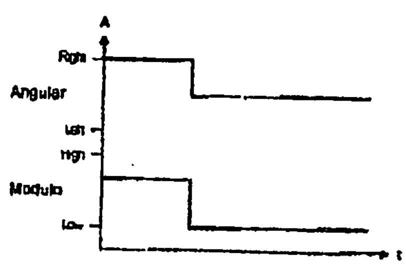
[0063] Similarly, the system may work as well with high to low pixel value change.

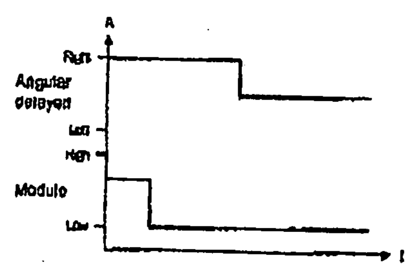
[0064] It is not possible to use overdriving at the extreme value of pixel intensity, i.e. zero and 255 for an 8-bit/color pixel, because there is no room to drive a higher or lower value. With the non-orthogonal stereoscopic display, it is possible to add room for overdriving by reducing the angular range. This way, the angular LCD of the display response faster at all values resulting in cross-talk reduction. Using a LCD overdrive as described hereinabove allows reducing crosstalk caused by the intermediary angle when the angle changes from one frame to the next, and reducing fast moving image smearing.

[0065] Now, turning to cross-talk reduction for fast moving images by using pre-angular adjustment, it is noted that intensity change in one eye may cause spurious light in the other eye. For example a pixel of the right eye image changes from bright to dark while the corresponding pixel of the left eye image is dark as shown below:

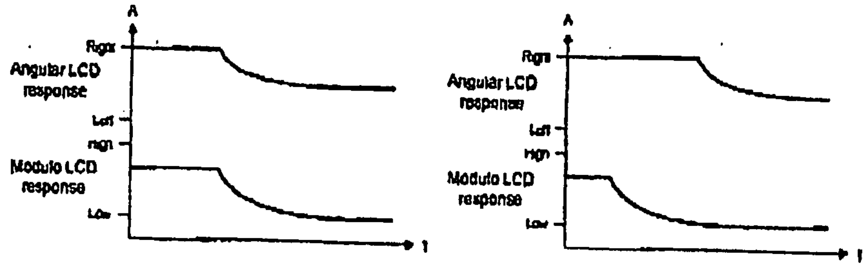


[0066] These signals are transformed to Modulo and Angular signal for the polar display. The left diagram below shows a normal system and the right one shows a system where the angular signal has been delayed (by one video frame for example):

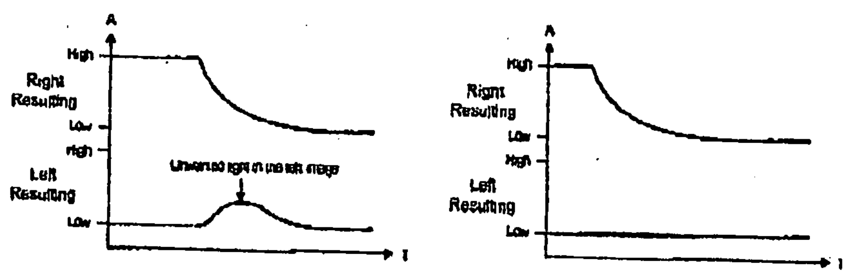




[0067] The corresponding response of the LCD pixel is as follows:



[0068] The resulting pixel intensity at the eye of the user, after the left and right polarized filter:



[0069] It may be seen that the slow response of the LCD opens a temporal gap where the light has passed through the left eye filter, while this is not the case in the system with the delayed angular signal. Similarly, it may be demonstrated that a similar light bump appears if the intensity of a pixel of one image goes from dark to bright while the other image is dark, and that by delaying the Modulo signal this time, this light bump may be prevented. A basic rule to apply delay may be as follows:

> IF a sub-pixel, the left or the right, go from dark to bright while the other corresponding pixel, the right or the left, is dark than delay the Modulo signal relative to the angular signal.
>
> IF a sub-pixel, the left or the right, go from bright to dark while the other corresponding pixel, the right or the left, is dark than delay the Angular signal relative to the Modulo signal.

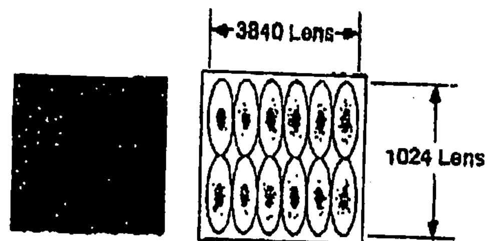
[0070] The overdrive technique may also be used to advance the other signal instead of using delay. The overdrive and delay techniques may be used together.

[0071] The superposition of two-pattern structures (the LCD cells in this case) causes a Moiré pattern due to the interference of the two structures. Figure 14 shows three light rays going unobstructed through a conventional LCD (left). In contrast, with the LCD of the present invention (right), only one incident light ray goes through a same pixel and a same color filter, while the other two are blocked by a color filter. The corresponding pixel of the two LCD panels work together so that at a given angle, there is a mismatch of the modulo pixel and the angular pixel, which results in parallax cross talk between the left and right images and degradation of the image resolution. The interference between the two LCD panel pixel structures causes low display brightness, which adds to the low brightness inherent to stereoscopic systems since the light is split between the two eyes.

[0072] The present invention further provides a method and system to solve the interference problem of stacked LCD panels and improve contrast at wide view angle. A display according to the present invention allows the collimation of light by adding one or more Micro-Lens Arrays layer placed before, in-between and/or after the two LCD panels. The models illustrated in Figures 15 and 16 allow very large viewing angle since the light goes thought the pixels at a fix angle, in contrast with standard LCD's wherein the contrast reduces and the color shifts with the angle of view. Figure 15 illustrates an embodiment with micro-lens arrays to collimate light within every color sub-pixel, and Figure 16 illustrates an embodiment using a front diffuser and

incident back light.

[0073] The pitch of the micro-lens arrays matches the LCD pixel pitch or sub-pixel pitch. The illustrations below shows the lens arrays that matches the pixel pitch for an 1280x1024 LCD:



Pixel
Front View

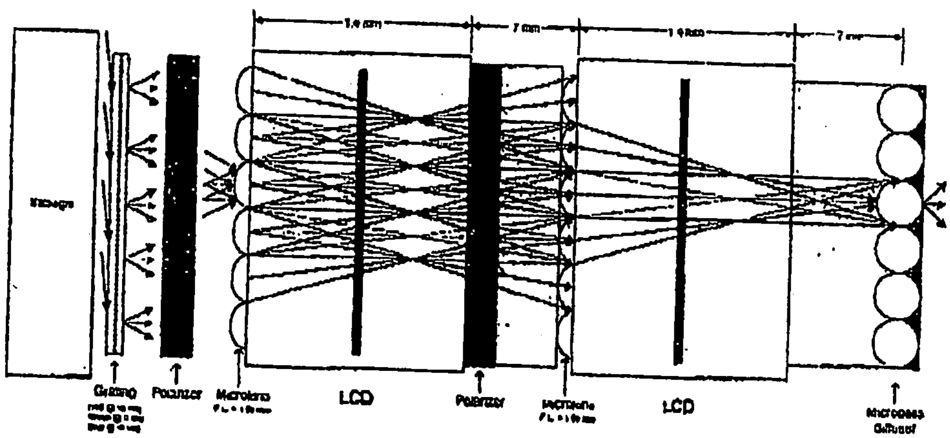
Lens Array
Front View

[0074] The light radiated from the backlight is focused through the pixel aperture of the first LCD and through the corresponding pixel aperture of the second LCD. Then the light coming out of the aperture of the second LCD may be diffused either by micro-lens or by a light diffuser layer or both. The micro-lens arrays may also be Gradians Index (GRIN) lenses type.

[0075] Furthermore, the fix angle of light inside the display of the present invention allows the use of cholesteric color and polarized filters, which may allow brightness gain of up to 600%, which compensates for the low brightness of the present invention stereoscopic display.

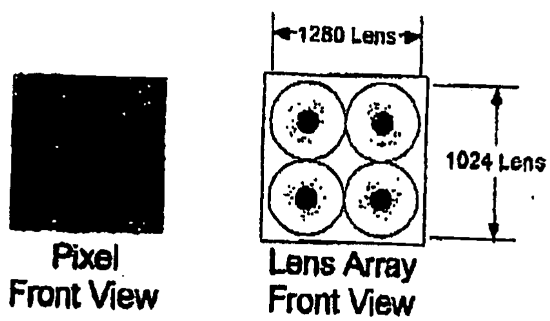
[0076] Another method to increase the brightness of a display according to the present invention makes use of a grating optical element that separates the color instead of filtering it, which, in combination with micro lens

arrays, may yield an increase in brightness by 300%. Also a micro-ball array with black mask is used to diffuse the light without de-polarizing the light (as with the other type of diffuser)



Vertical Side View

[0077] The lens arrays matches the LCD pixel pitch as shown below:

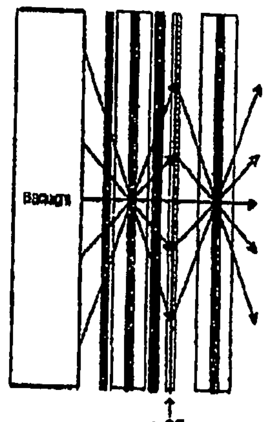


[0078] Such making use of micro-lens arrays or GRINS lens arrays resolves the problem associated with the superposition of two pattern structure (the LCD cells in this case) which causes a moiré pattern due to the

interference of the two structures, discussed hereinabove in relation to Figure 14, by preventing the light ray at certain angle to go through the adjacent modulo LCD pixel than the corresponding (at the same coordinate) angular LCD pixel which otherwise would result in parallax cross-talk between left and right image and a degradation of the image resolution. Therefore, the brightness of the is increased by allowing more light going through pixel aperture, and a very large viewing angle is obtained because the light go thought pixel at fix angle.

[0079] In still a further embodiment, the first and second LCD images replication is performed using mini-lens arrays or GRINS lens arrays. Figure 17 shows such a display system, for replicating the image of the first LCD on the second LCD. One or more mini-Lens Arrays layers are placed in-between the two LCD the stereoscopic display. These mini-lens arrays are selected to form a non-inverted 1:1 image projection, so that the light going through a sub-pixel of the first LCD goes through the corresponding sub-pixel of the second LCD. The pitch of the mini-lens arrays does not have to match the LCD pixel pitch. The mini-lens arrays may also be Gradians Index (GRIN) lenses type.

[0080] A display using Holographic Optical Elements sheets to redirect the light to the corresponding pixels of the first LCD and the second LCD is shown below:



[0081] As before, replication of the first and second LCD as just described allows resolving the problem associated with the superposition of two pattern structure (the LCD cells in this case) which causes a moiré pattern due to the interference of the two structures and preventing the light ray at certain angle to go through the adjacent modulo LCD pixel than the corresponding (at the same coordinate) angular LCD pixel which would otherwise result in parallax cross-talk between left and right image and a degradation of the image resolution

[0082] The LCD of the present invention may be integrated as illustrated in (see Figure 18), wherein the 2 LCD panels of the present invention are integrated into one LCD panel. By having the modulo and the angular LCD structures close to each other, the light from the backlight is directed through both corresponding pixel even at wide angle. A typical LCD panel is made of two glass substrates of a thickness typically around .7mm, one with the active part of the LCD and the other substrate having the black matrix, the color filter and in certain case an IPO conductive layer acting as the anode (or cathode). The liquid crystal is located in between these two substrates. For an integrated

LCD according to the present invention, two active .7mm substrates may be used, the first one controlled by the Modulo signal and the second one controlled by the Angular signal. Between the two substrates, a very thin sheet, less than .2mm (glass or other material) with an IPO conductive layer and the color filter is placed, and between the two active glass substrates and the middle thin sheet is the liquid crystal. The two active substrates and the color filter are to be aligned. The second active substrate may have a black matrix layer. Again, such a structure resolves the problem associated with the superposition of two pattern structure (the LCD cells in this case) which causes a moiré pattern due to the interference of the two structures, and prevents the light ray at certain angle to go through the adjacent modulo LCD pixel than the corresponding (at the same coordinate) angular LCD pixel which without the invention result is parallax cross-talk between left and right image and a degradation of the image resolution.

[0083] Although the present invention has been described hereinabove by way of embodiments thereof, it may be modified, without departing from the nature and teachings of the subject invention as described herein.

WHAT IS CLAIMED IS:

1. A Stereoscopic display systems as described herein.

ABSTRACT OF THE DISCLOSURE

High quality flat panel stereoscopic display systems and method

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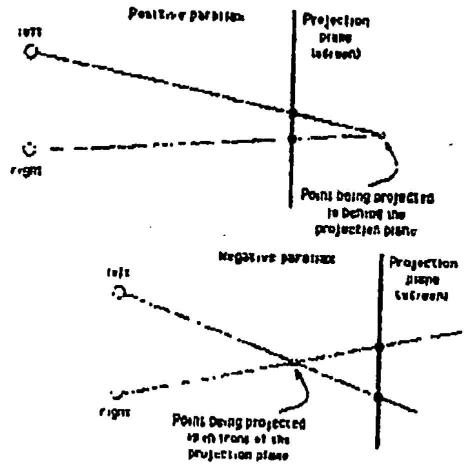


Figure 1 (PRIOR ART)

Figure 2 (PRIOR ART)

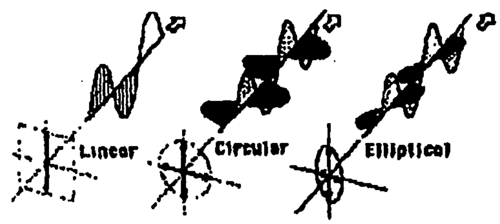


Figure 3 (PRIOR ART)

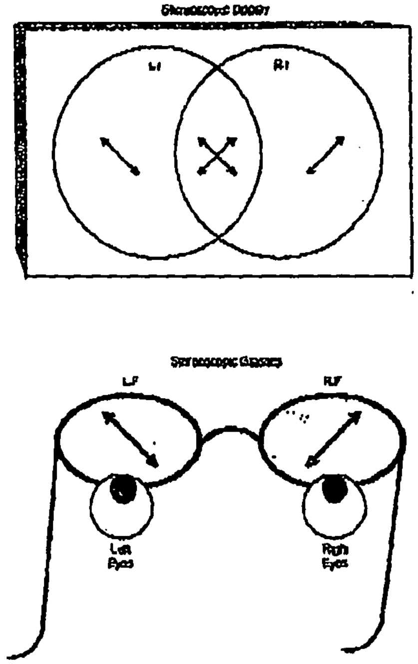


Figure 4 (PRIOR ART)

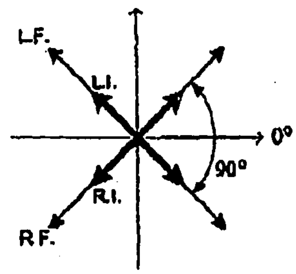


Figure 5 (PRIOR ART)

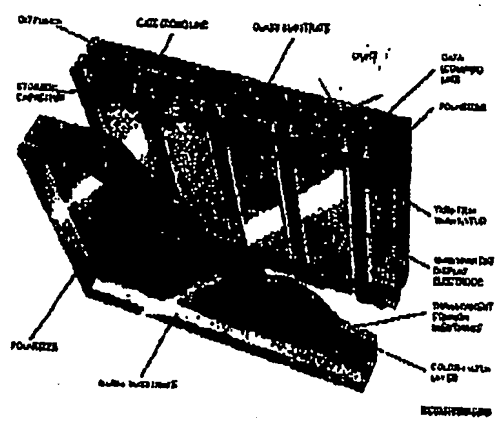


Figure 6 (PRIOR ART)

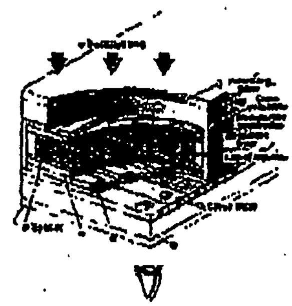


Figure 7 (PRIOR ART)

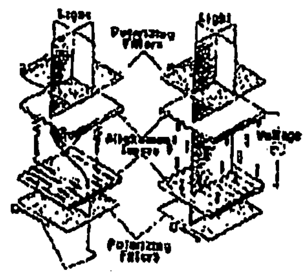


Figure 8 (PRIOR ART)

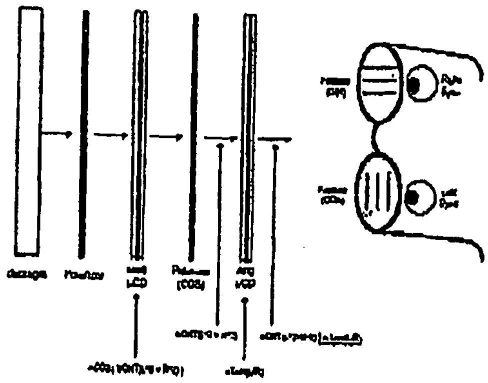


Figure 9

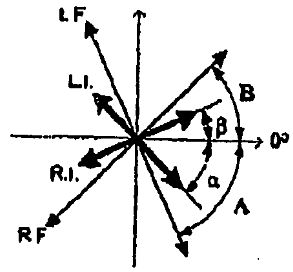


Figure 10

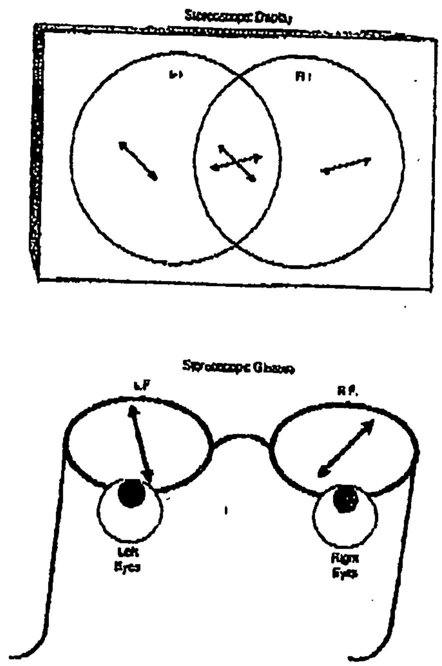


Figure 11

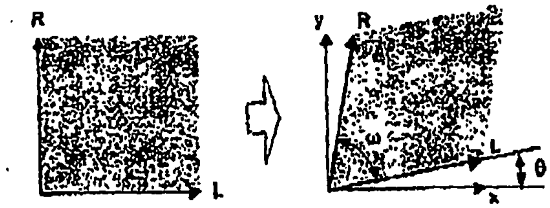


Figure 12

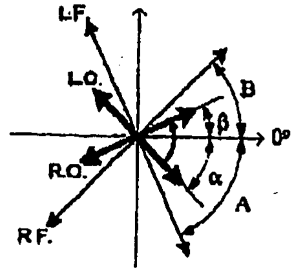


Figure 13

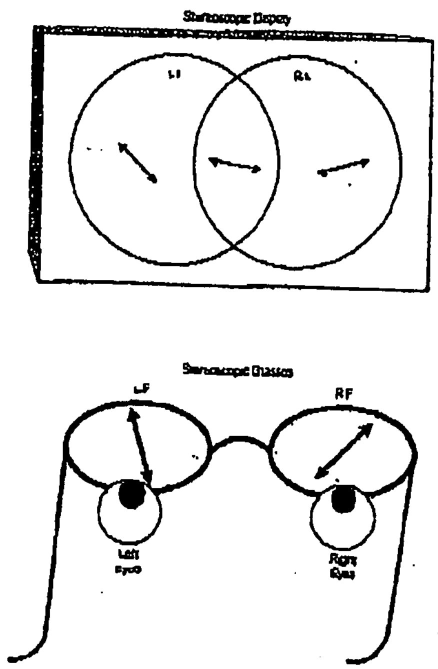


Figure 14

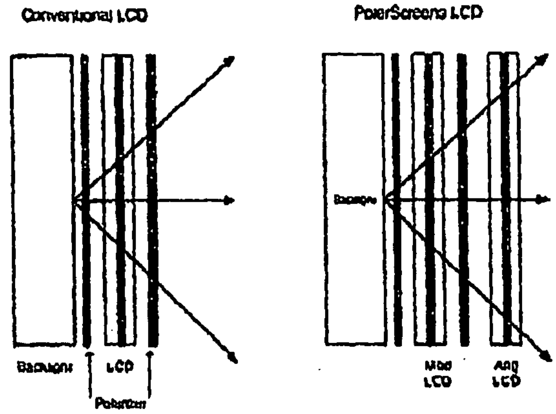

Conventional LCD
PolarScreens LCD
Backlight
LCD
Polarizer
Mod
LCD
Ang
LCD

Figure 15

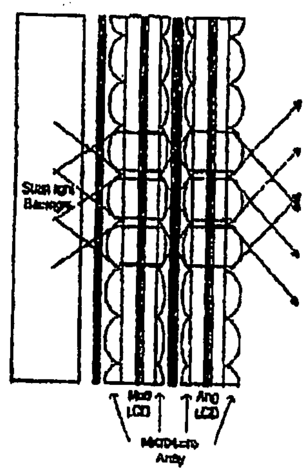


Figure 16

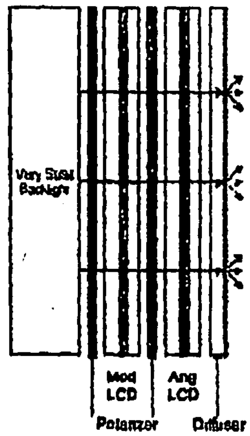


Figure 17

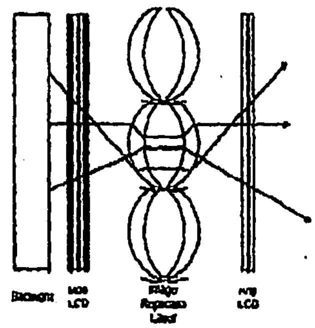
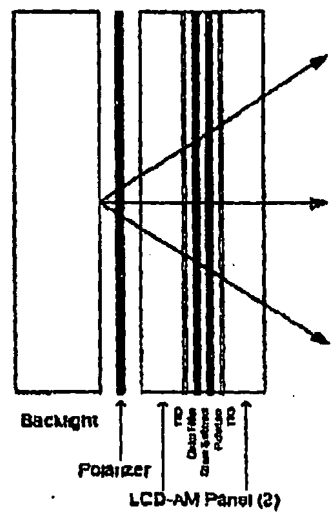


Figure 18



DATE 4-15-07

APPLICATION NUMBER 10/586108

DOC CODE 371P

DOC DATE

DELIVER THE ATTACHED FIFLE/DOCUMENT TO THE TC SCANNING CENTER

CONTRACTOR: THE ATTACHED FILE/DOCUMENT MUST BE INDEXED AND SCANNED INTO IFW WITHIN 8 WORK HOURS; UPLOADING OF THE SCANNED IMAGES SHOULD OCCUR NO LATER THAN 16 WORK HOURS FOLLOWING RECEIPT OF THIS REQUEST

AFTER SCANNING, ORIGINAL DOCUMENTS SHOULD BE BOXED IN ACCORDANCE WITH INSTRUCTIONS